

MINERAL RESOURCES RESEARCH AT THE ENGINEERING EXPERIMENT STATION OF THE OHIO STATE UNIVERSITY

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The Engineering Experiment Station of The Ohio State University was established by legislative act in 1913. It is affiliated with the College of Engineering and operated as a part of that division of the University. As stated in the law, "The duties of the Engineering Experiment Station shall be to make technical investigations and to supply engineering data which will tend to increase the efficiency and safety of the manufacturing, mineral, transportation and other engineering and industrial enterprises of the state and to promote the conservation and utilization of its resources." Any of the state agencies may seek assistance from the Station; the expense of the research being borne in full or in part by the petitioning agency, according to the judgment of the Engineering Experiment Station Advisory Council. Citizens of Ohio, business enterprises, etc., may also seek such assistance, subject to certain specifications and contractual agreements.

Studies of Ohio's mineral resources are a very important function of the Engineering Experiment Station. Because of the importance of this work and the need for better integration of effort, a special project was established in 1946. One of the duties of the supervisor of this project is to act as liaison between the Engineering Experiment Station, industry and other state and federal agencies. As a result of many technical investigations of Ohio's mineral resources certain facts and trends have been revealed that may be of interest and assistance to the geologists of the state. These will be considered under each of the major lines of interest of the Engineering Experiment Station.

FUELS RESEARCH

As a result of increased general interest in synthetic fuels many low-temperature carbonization tests of coals and shales have been made in recent years. It has been found that the oil yield from Ohio coals, by this method, compares favorably with yields from coals of other states. In 1948, the Geological Survey of Ohio sampled several coals and carbonaceous shales. These samples were analyzed at the Engineering Experiment Station and a bulletin summarizing the data is in preparation.¹

Another phase of the synthetic fuel study has been to investigate the Ohio shale as a source of oil. Analyses of sample suites taken through the entire thickness of the formation show a general three-fold division of the unit in southern Ohio. The upper 80 to 90 feet are the richest, yielding from about 5 to 14 gallons of oil per ton. The middle portion gives the lowest assays, 0 to 4 gallons per ton and the lowermost portion gives somewhat intermediate oil yields. These facts are consistent with the three-fold division of the Ohio shale noted in the northern part of the state.

From analyses to date it may be stated that the Ohio shale is not suitable for oil production *under present economic conditions*. Should the economic factors undergo a distinct change, or should sufficiently valuable by-product uses be discovered, certain areas of this large deposit of low-grade material may be amenable to exploitation. The survey of this resource is not complete but sufficient data

¹Bowen, C. H., Smith, W. H., and Krumin, P. O. "Further Studies of Ohio Coals and Shales," Ohio State University Engineering Experiment Station, *Bull.* 143.

are available to indicate that further investigation can be made somewhat incidental to other research problems.

Coal Beneficiation

Other fuels research includes a coal beneficiation project whose aim is to improve the quality of Ohio coals for the general fuel market and for use in the production of synthetic fuels. This coal beneficiation project is being done in cooperation with the Division of Geological Survey. The Meigs Creek, or number 9 seam, is the coal being investigated at present, inasmuch as it constitutes the largest undeveloped reserve of coal in Ohio. The research will attempt to determine the nature and mode of occurrence of the sulphur and ash, and to determine what processing will be required to economically remove those impurities.

The beneficiation program may have more far reaching results than those expressed in our immediate aims. No Ohio coal is used by the coking industry at present, but when the low sulphur coking coals of the Appalachian Field are exhausted certain of Ohio's coals may be beneficiated to the extent that they too will be used in this industry. Demorest¹ found that the numbers 6, 7 and 8 seams would coke, especially if cleaned and then blended with low-volatile coal.

Underground Gasification

A rather new development in the utilization of solid fuels is the underground gasification of coal. In this process the fuel values are extracted as a gas without recourse to customary mining techniques. The coal seam is set on fire and the gases extracted by means of drill holes and/or simple mine entries. Since the strata overlying the coal form the retort, the character and thickness of these strata are of prime importance. According to the rather incomplete data available at present, the following generalizations may be made:

1. The cover should be quite thick in order that it may absorb any subsidence.
2. A thick shale series seems desirable; first, because through-going joints are not so common, and secondly, because in subsiding the broken shale rapidly increases in volume, filling the void and hence does not tend to break to the surface.
3. Bloating and swelling of the roof rock under the action of heat is desirable; such bloating tendencies are often present in carbonaceous, pyritic and micaceous shales. The expansion of the roof rock tends to fill the burned-out area and crowd the air blast against the fire face. Limestone is undesirable as a roof rock because the carbonate decomposes, creating a still larger void and the carbon dioxide given off dilutes the effluent gases.

CERAMICS RESEARCH

A great deal of the research at the Station has been in the field of ceramics. In structural clay products, for instance, the aim has been to find, test and develop standards for better raw materials; another aim is to develop better blending methods so that these raw materials will produce a ware having high strength, a long firing range and low porosity. It has been found that many of Ohio's shale units are admirably suited for such wares. In fact, a request was recently received from a North Carolina ceramic producer for sources of such Ohio shales so that he could purchase several carloads a week for blending with local material.

Several of the shales in the Coal Measures are found to possess very desirable qualities. Of these the Clarion shale, of Hocking and Perry counties, is an outstanding example. Two Conemaugh shales, the Buffalo and Brush Creek, have been found suitable at least in places. The Mississippian Bedford shale is also widely used for brick and tile, and some of the shales of the Cuyahoga formation are utilized locally.

¹Demorest, D. J. "Carbonization of Ohio Coals," Ohio State University Engineering Experiment Station, *Bull.* 46, 1928.

A shale showing the following properties will generally warrant testing for structural clay products:

1. A moderate amount of free silica.
2. Low carbon content.
3. Fairly high iron content, but disseminated and in the oxide form. Pyrite is deleterious.
4. Soft and friable, which is a fair indication of good workability.
5. No marked efflorescence at the outcrop which indicates the presence of harmful sulphur, sulphates and other soluble salts.
6. Presence of small quantities of finely divided (sericitic) mica.
7. Low lime and/or magnesium content, these constituents tend to shorten the firing range and to act as a bleach.

Lightweight Aggregates

Several Ohio materials are suitable for the manufacture of lightweight aggregates. Among the units tested and found good are the Ohio shale, Minford Silts, Bedford shale and several of the coal formation shales. Lightweight aggregate is essentially an artificial, vesicular lava. The raw material is heated rapidly so that the mass is viscous (pyroplastic) at the time that certain minerals decompose with the evolution of gas. The gas bubbles are entrapped in the somewhat viscous mass which is cooled before the gas completely escapes. Not much gas is required and, at present, it is believed that carbon and pyrite are the chief gas sources. Finely divided mica, in moderate quantities aids in fluxing and the water inherent in the mica molecule may aid in the blowing action.

Other Ceramic Research

The Minford Silt has been found to be a good glazing material if blended with some fluxing agent; by itself it is too refractory.

A profitable line of future investigation would be the beneficiation of some of our more plastic clays by the flotation process. There is a distinct possibility that clays such as the Clarion of Vinton County and the Lawrence of Lawrence County could be made into good substitutes for ball clays in the manufacture of whiteware.

FOUNDRY SAND

The Experiment Station and the Ohio Division of Geological Survey are sponsoring an investigation of Ohio foundry sands; although the project is far from complete, certain facts and trends are now known.

So-called synthetic sand and clay mixtures are replacing naturally bonded molding sands, especially in the large foundries. This trend will work to the disadvantage of certain naturally bonded sand producing areas in the state, such as Gallia, Muskingum, Erie and Ashtabula counties. This need not be a total loss inasmuch as Ohio is rather well supplied with sources of clay-free base sands. The Sharon, Massillon and Black Hand sandstones are important producers of synthetic sands and are capable of even greater production. The Berea sandstone and the dune sands of the old lake beaches can also be treated (washed) to satisfy demands for which present producing units cannot qualify.

A second trend in foundry practice may also aid our synthetic sand producers. In the past the foundries wanted well-sorted sands, those in which the bulk of the sand was retained on three adjacent sieves, hence sands such as those from the St. Peter formation and from the dunes in Michigan commanded a premium market. Present foundry practice requires less well-sorted sands in which the bulk of the material is retained on 5 or 7 adjacent sieves. Under these specifications the well-sorted sands will lose their premium rating in the industry and Ohio's sands may be more favorably received by the foundry industry.

Present research is directed at other traditional foundry specifications, some of which work to Ohio's disadvantage. The trends seem to indicate that *some* of these specifications are merely traditions and have little basis in scientific fact. If and when these traditions are exploded (and it will be a difficult task) Ohio sand producers may be in a better competitive position than they now are.

LIMESTONE

In 1948, the Engineering Experiment Station and the Division of Geological Survey co-operated in drilling a core hole through the Maxville limestone in Muskingum County. This hole was part of a program to explore sources of high-calcium limestone in Southern Ohio. The hole bottomed in the Vinton shales at 385 feet and showed about 70 feet of Maxville overlying them. The analyses indicate the existence of about 26 feet of rather good limestone and nearly the entire thickness is suitable for cement manufacture. The basal 8 feet of the Maxville shown in the core is a brecciated dolomitic limestone which, with the other lithologic and paleontologic variations noted could form the basis of an interesting geological study. As might be surmised from the thickness of the Maxville, the overlying Pottsville section was very short.

Other investigations in limestone and dolomite include the plotting of all existing quarries and collecting data on the physical and chemical properties of the rock. These data may be of some assistance in the correlation of strata and may also assist in noting areal variations in the units involved.

This paper has been a summary of *some* of the data available, at present. The incomplete results of some projects, and the contractual nature of others has precluded the making of any further statements at this time. However, the Station by means of its various publications, will make these results available as soon as possible.

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